A FURTHER NOTE ON THE LORAIN, OHIO, TORNADO OF JUNE 28

By B. M. VARNEY
[Weather Bureau, Washington, Sept. 11, 1924]

Supplementing the account of the Lorain tornado published in the June REVIEW, we are able, through the courtesy of the *Engineering News-Record*, to reproduce the diagrams [18] herewith.

Previous report describes the area damaged as tapering from a wide west end at the shore of Lake Erie to nothing beyond the eastern end of the city. Figure 1, drawn on the basis of a detailed survey, confirms this. Figure 2 effectively shows an interpretation of the reason for the observed shape of the area, on the assumption of a gradual rising of the tornado funnel as it moved eastward. This is at variance with the statement of an observer within the city, quoted in the June REVIEW, describing the "perfectly formed, funnel-shaped cloud, with its tail flowing or waving gracefully from it, while the larger part of the cloud was revolving very fast and increasing as it grew nearer." It is in agreement, however, with the account of the experience of those on board the yacht observations, in the *Engineering News-Record*, as follows:

> The storm has been traced from Sandusky, about 30 miles west of Lorain, to Avon village, about 20 miles east of Lorain. After the storm had reached Sandusky it apparently descended and was at its lowest point between Lorain and Sandusky, in Lake Erie. As it proceeded eastward and reached the shores of Lake Erie in the vicinity of Lake View Park (Lorain) it started to rise across Lorain. When the storm reached the easterly limits of the city it was at such an elevation that no damage was done on the surface of the earth.
>
> From a study of the devastated area within the limits of Lorain, it is very apparent that the storm was of the usual funnel shape. There is no other conceivable shape which would leave a path 6,000 feet wide at the westerly limits of the city, and 500 feet wide at the easterly limits, which path uniformly contracted between the two points. And there is no way that a funnel-shaped tornado could leave such a path without gradually rising or falling in the direction, respectively, of the smaller or larger area. * * *
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> After surveying the types of [structural] failures it is found that, in general the exploding buildings lay both along the center line

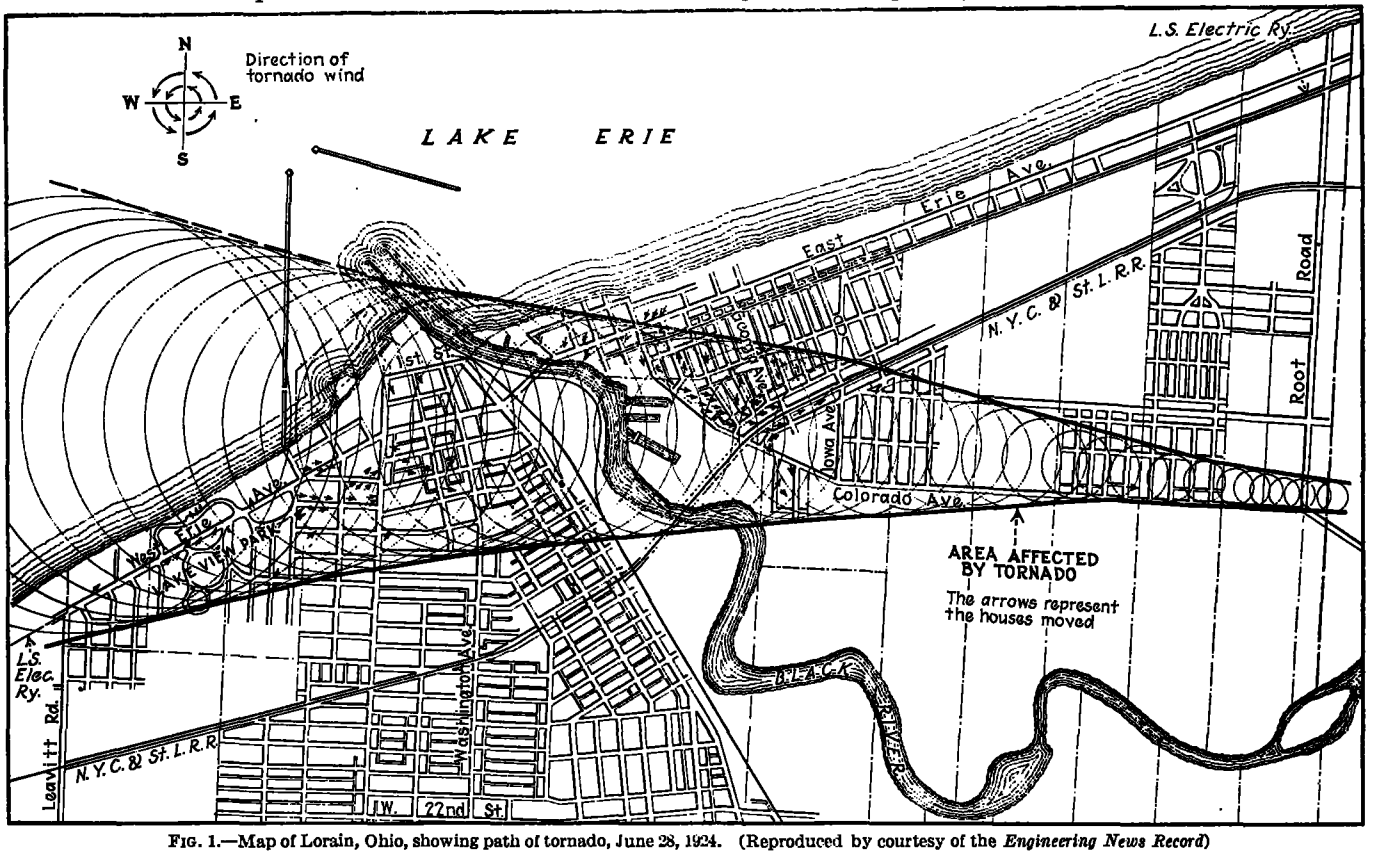

FIG. 1.—Map of Lorain, Ohio, showing path of tornado, June 28, 1924. (Reproduced by courtesy of the *Engineering News Record*)

Oswichee, who "saw a very black cloud estimated at one-half mile wide at the water and much wider at the top." The *Oswichee* became involved in the storm about 7 miles west of Lorain. The zone of damage where the cloud came on shore is reported in the *Engineering News-Record* as being some 6,000 feet wide. Though tornadoes frequently display an extraordinary hop-and-skip motion as they progress, it seems unlikely that in 7 miles the form of this tornado would change from that of a truncated inverted cone "about one-half mile wide at the water," to a funnel "with its tail flowing," and back again to the truncated cone 6,000 feet wide at the ground. It is possible that the observer first quoted saw a whirl secondary to the main cloud.

Mr. C. C. Miller, city engineer of Lorain, gives his version of the occurrence, with conclusions from his of the storm and along the outer edges. This would seem to indicate a [partial] vacuum extending through the the center of the whirling mass of air and one immediately outside of the whirling mass.

It will be noted in Figure 1 that the houses in the westerly section of the city were moved practically all in the same direction. This is due to the larger diameter of the storm at this point. On the easterly side of the city, where the diameter was small, the tail of the tornado alone was the effective part. Here the buildings were moved in nearly every direction.

The proof that the storm was a whirling mass of air is shown by the fact that furniture and smaller buildings were first thrown to the north and immediately houses and buildings were demolished by a stronger wind coming from the north. The wind when moving in the same direction as the storm was very much more intense than when the wind traveled in a direction opposite to that of the storm.

[18] Eng. News-Record, 93, no. 5, July 31, 1924, pp. 190-191.

The item of greatest interest in the above quotation is that regarding the possibility of a partial vacuum existing in connection with the periphery of the whirl, and the suggestion that it may be sufficiently low to cause explosive effects. In reply to a query as to whether the identical, Mr. Miller offers the comment below, with Figure 3 in illustration of it. The possibility that such a condition may accompany tornadoes has, it is believed, not hitherto been suggested, and is therefore presented for the consideration of our readers:

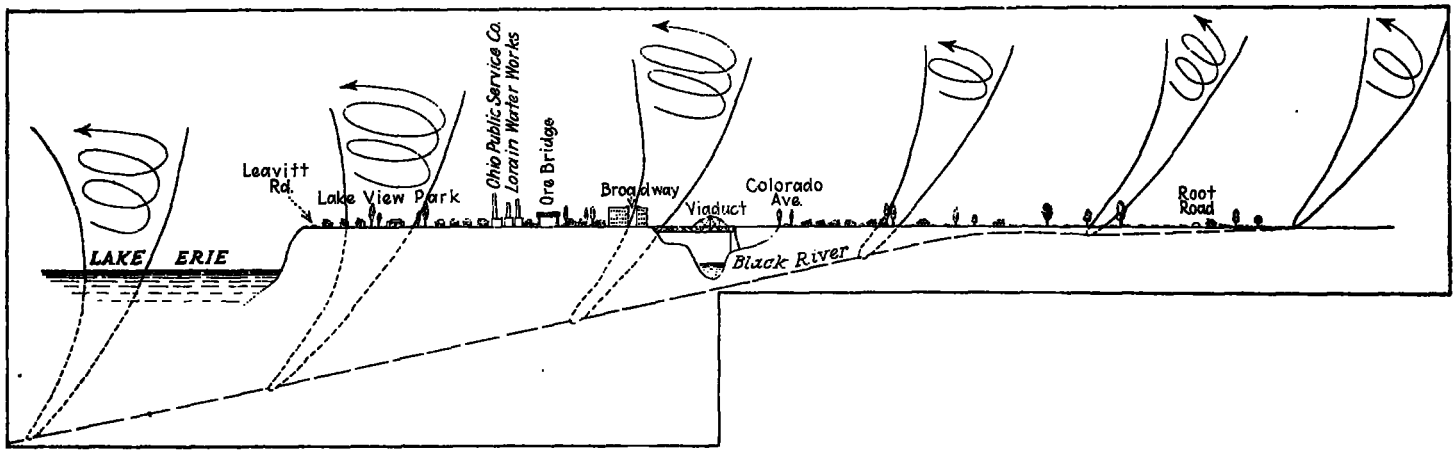

FIG. 2.—Diagrammatic cross sections of the Lorain tornado, showing relation of decreasing area at the earth's surface to the rise of the funnel cloud. (Reproduced by courtesy of the *Engineering News Record*)

types of structural failure in both the central partial vacuum and the border area were so far identical as to indicate practical certainty that the causes were also

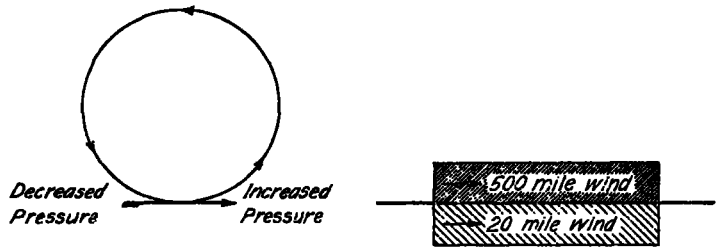

FIG. 3.—Conditions of wind and pressure in relation to the suggested partial vacuum at edge of tornado. (C. C. Miller)

Referring to the print, Figure A [not reproduced. It depicts damage by outward bulging of walls.—B. M. V.] shows the method in which the houses were damaged on the outer edge and also in the center. The walls were bulged outward or blown completely out, showing of course the presence of a vacuum. * * * There were a large number of houses damaged in the same manner along the edges of the storm's path. It does not seem to me that a vacuum at the outer edge of the storm's path would be unusual or impossible. If there is a condition which would produce an increased pressure, there would also exist an area in which the pressure would be decreased. The cause of the vacuum in the center of the storm is of course due to the centrifugal force, and the outer vacuum, I believe, is due to the difference in velocity of the two volumes of wind. Figure 3 shows * * * a condition which would be favorable for a vacuum along the line which separates the two winds traveling at a different rate of speed. I would believe that if a vacuum really exists on the outer edge of the storm, that it would necessarily be very narrow.

NOTES, ABSTRACTS, AND REVIEWS

SOLAR AND TERRESTRIAL RADIATION[19]

551.52(048)

By A. ÅNGSTRÖM

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Continuous records of the total radiation received from the sun and sky have been obtained at Stockholm since July, 1922. From these the annual and daily variation of the radiation received may be obtained, and as the direct solar radiation may be computed from the time of sunshine, the variation, both of the direct and the diffused radiation, is known. The total amount of radiation received during the day, Q_s, may be expressed in the form: $Q_s = Q_0 (0.25 + 0.75S)$, if Q_0 is the amount on a perfectly clear day, and S is the time of sunshine expressed as a fraction of the greatest possible time. The total radiation received is a minimum in the afternoon of days when the sky is less than half-covered with cloud, and a maximum in the afternoon of overcast, or nearly overcast, days; this is due to the operation of convection.

The nocturnal radiation has been measured at stations where the temperature ranged from −30° C. to +30° C. The results obtained show that the radiation from a black surface at a temperature between these limits may be divided into three groups of waves: (1) About 25 per cent of the radiation passes through the atmosphere without absorption, and is independent of the thickness of the atmosphere and the amount of water vapor it contains; (2) about 50 per cent is totally absorbed by a thin layer of the atmosphere, probably in the lowest 30 meters at ordinary vapor pressures; (3) about 25 per cent is subjected to a variable absorption, depending chiefly on the amount of water vapor present.—*A. W. L.*

[19] Roy. Met'l Soc. Jour., April, 1924, 50: 121–126. Report to the International Commission for Solar Research on Actinometric Investigations of Solar and Atmospheric Radiation.